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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/069,031	07/05/2002	Johannes Kaeppeler	24230PCT/US	7779

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	PAPER NUMBER
1722	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/25/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

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Office Action Summary	Application No.	Applicant(s)	
	10/069,031	KAEPPELER ET AL.	
	Examiner	Art Unit	
	Matthew J. Song	1722	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 November 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *40-67* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *40-67* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11/14/2006 has been entered.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claim 46, 47, 50-51, 54, 56, and 60-63 are rejected under 35 U.S.C. 102(b) as being anticipated by Wengert et al (WO 97/06288A1).

In an apparatus for chemical vapor deposition of semiconductor wafers, note entire reference, Wengert et al discloses a reaction chamber **130** with a plurality of radiant heat lamps are arranged around the reaction chamber to heat a susceptor **134** and a wafer **144** (pg 15, ln 15-36), this reads on applicant's heating on all sides of the reactor. Wengert et al also discloses a gas injector **156** is positioned upstream of a process chamber **130** and includes a plurality of reactant gases flow horizontally **112** (pg 16, ln 10-35 and Fig 8), this reads on applicant's at least one

process or carrier gas is introduced just ahead of the substrate. Wengert et al also disclose a plurality of heat lamps heat the susceptor (pg 15, ln 25-35), this reads on applicant's holder is actively heated during the heating of the substrate. Wengert et al discloses a gas injector **156** includes water cooling channels and intended to maintain the temperature of the material for the gas injector at approximately 60°F or cooler (pg 23, ln 1-30), this reads on applicant's actively cooled gas inlet. Wengert et al also discloses an inlet that extends in a direction transverse to a plane of a front surface (Fig 8).

Referring to claim 46, Wengert teaches a heated reactor (Fig 27), this reads on applicant's actively heated flow channel, a rotatable susceptor (Abstract), an inlet **374** just ahead of the susceptor (Fig 27), an outlet (Fig 28a), a horizontal flow(Fig 27), a heater **378a, 378b**. Wengert also teaches thermocouples **102** to sense temperature, which allows comprehensive feedback regarding temperature and enables adjustment of the radiant heating lamps surrounding the chamber, this reads on applicant's temperature control device. Wengert discloses cooling channels within a gas injector, this reads on applicant's coolable gas inlet. The radiant heating lamps are capable of performing the claimed intended use of heating to 1100-1800°C.

Referring to claim 47, Wengert discloses a rotationally symmetrically inlet and outlet (Fig 28a).

Referring to claim 50, Wengert discloses a rotatable susceptor. (Abstract).

Referring to claim 51, the limitations further limit only the intended use of the temperature controller. The apparatus taught by Wengert et al is capable of performing the claimed intended use; therefore reads on the claim.

Referring to claim 54, Wengert discloses quartz and graphite, this reads on applicant's highly conductive material.

Referring to claim 56, Wengert discloses a liquid medium.

Referring to claims 60-61, Wengert discloses a boundary wall which is capable of being cooled.

Referring to claim 62, Wengert discloses two substrates.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 49 and 57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wengert et al (WO 97/06288 A1), as applied to claims 46, 47, 50-51, 54, 56, and 60-63 above, and further in view of Burk (US 5,788,777).

Wengert et al teaches all of the limitations of claim 49, as discussed previously, except Wengert et al does not teach a turning deice for rotation of the substrate by gas foil rotation.

Burk teaches a modified susceptor for epitaxial growth reactors for growing silicon carbide epitaxial layers. The susceptor assembly has multiple substrate holders which are levitated and rotated by an inert gas flow (Abstract), this clearly suggests applicant's gas foil rotation. Burk also teaches the susceptor is made of graphite, SiC or SiC coated graphite (col 4, ln 10-12).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wengert et al using the susceptor taught by Burk because substrate holders which are levitated and rotated by an inert gas flow which avoid cracking problems associated with high temperature growths ('777 col 3, ln 10-65).

Referring to claim 57, the combination of Wengert et al and Burk does not teach an adapter piece as claimed. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wengert et al and Burk by using an adapter piece, as claimed, to control flow.

6. Claims 48, 55, 58-59, and 64-66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wengert et al (WO 97/06288 A1) as applied to claims 46, 47, 50-51, 54, 56, and 60-63 above, and further in view of Flynn et al (US 6,447,604).

Wengert et al discloses all of the limitations of claim 48, as discussed previously, except the substrate holder having a continuous inert coating such as TaC or NbC.

Flynn et al discloses a method of reducing defects and thereby improving the quality of epitaxial layers formed in a reactor by vapor phase epitaxy (i.e. CVD). Process conditions include temperatures of from 500-1250°C and pressure from 1-1000 torr. Materials grown include AlN and GaN (abstract). Flynn et al also discloses TaC and NbC inert coating are made on the susceptor and reactor parts. (col 7, ln 50-60).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wengert et al by coating the susceptor and reactor with TaC or NbC to help reduce defects present in GaN.

Referring to claims 58-59, It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wengert et al and Flynn et al by using different inert materials in the outlet segments and on the substrate holder because at least two inert materials were known (TaC and NbC) and described as alternatives. Those of ordinary skill in the art would have expected different materials to have different properties.

Referring to claim 63, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the prior art by using graphite because graphite is a well known material of construction which efficiently transfers heat, which is desirable.

7. Claims 53 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wengert et al (WO 97/06288 A1) as applied to claims 46, 47, 50-51, 54, 56, and 60-63 above, and further in view of Hirata et al (US 4,542,273).

Wengert et al discloses all of the limitations of claim 53, as discussed previously, except the boundary wall heating by two separate circuits.

Hirata et al discloses heating with multiple circuits. (col 1, ln 1-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wengert et al by using two circuits for induction heating for independent control and because it is less costly (col 1, ln 10-25).

8. Claim 52 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wengert et al (WO 97/06288 A1) as applied to claims 46, 47, 50-51, 54, 56, and 60-63 above, and further in view of Crawley et al (US 5,871,586).

Wengert et al discloses all of the limitations of claim 52, as discussed previously, except a combination of high frequency, lamp and resistance heating means.

In an apparatus for MOCVD, note entire reference, Crawley et al teaches heating systems which include induction heating, radiation heating or resistance heating as desired. (Col 3, ln 40-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wengert by using a combination of known heating means, as taught by Crawley et al, because a combination of known equivalents is held to be obvious. (MPEP 2144.06).

9. Claim 67 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kordina et al (US 5,792,257) in view of Crawley et al (US 5,871,586) and Wengert et al (WO 97/06288 A1).

In a method of epitaxially growing SiC or Group III nitride, note entire reference, Kordina et al teaches heating susceptor walls surrounding a channel **1** for heating a substrate **2** and a precursor within the channel, this clearly suggests applicant's actively heated flow channel reactor and heating is accomplished by an elevated temperature of heated walls of a chamber of the reactor on all sides of the reactor chamber. (col 4, ln 55-67). Kordina et al also teaches heating the substrate to a temperature of 1500-1700°C (col 5, ln 15-35), this clearly suggests applicant's heating to a temperature of 1100-1800°C. Kordina et al also teaches a susceptor and a SiC plate **5** for holding the substrate **2** (Fig 2). Kordina et al teaches process gases enter through an inlet **3** and flow horizontally through the reactor containing a substrate **2** (Fig 1, Fig 2 and col 5, ln 1-15), this clearly suggests applicant's process gas is introduced just ahead of the hot substrate and flows in a horizontal direction past the substrate. Kordina et al teaches epitaxially forming SiC, this clearly suggests heteroepitaxial or homoepitaxial deposition. Kordina et al teaches a inlet extends in a direction transverse to a plane of a front surface of the substrate. (Figs 1-3)

Kordina et al does not teach the process or carrier gases are actively cooled to a temperature well below a process temperature that is present within the reactor.

In a method of chemical vapor deposition, note entire reference, Crawley et al teaches first and second precursors of the material to be deposited are cooled prior to entry into the reaction chamber (Abstract). Crawley et al also teaches a means for cooling conduits connecting the precursors to the reaction chamber (col 2, ln 1-45 and col 4, ln 55-67), this clearly suggests applicant's actively cooling the process gas before being introduced into the reactor.

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kordina et al by using the cooled conduits for introducing process gases to a reactor, as taught by Crawley et al, to prevent premature reaction of the process gases and provide good mixing of the gases (col 1, ln 50-67).

In regards to the limitation, "at least one process or carrier gas is introduced via a gas inlet of the reactor just ahead of the hot substrate, wherein an opening of the inlet extends in a direction transverse to a plane of a front surface of the substrate for directing the gases to flow in a horizontal direction parallel to and past the front surface of the substrate" in independent claims 40 and 67, this is an apparatus limitation which further limits the process by specifying the opening of the inlet. Apparatus limitations, unless they affect the process in a manipulative sense may have little weight in process claims. *In re Tarczy-Hornoch* 158 USPQ 141, 150 (CCPA 1968); *In re Edwards* 128 USPQ 387 (CCPA 1967). In the present case the inlet of the opening is not taught by the combination of Kordina et al and Crawley et al, however the apparatus limitation does not produce a manipulative difference between the prior art. The prior art teaches flowing gases in a horizontal direction parallel to and past the front surface of the substrate ('320 Fig 1). The absence of an inlet opening transverse to the front surface does not produce a patentable process difference because the prior art teaches flowing the gas horizontally over the substrate since the apparatus limitation is given little weight.

In the alternative, the feature would have been obvious to one of ordinary skill in the art because Wengert et al teaches an inlet opening transverse to substrate front plane and turning the gas such that the gas flows horizontally and parallel to the front surface of the substrate, note Fig 8. It would have been obvious to a person of ordinary skill in the art at the time of the invention

to modify the combination of Kordina et al and Crawley et al by using the inlet taught by Wengert et al and other types of joints and piping in the construction of a deposition apparatus to manipulate the flow gases while maximizing space.

10. Claims 40-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kordina et al (US 5,792,257) in view of Crawley et al (US 5,871,586) and Wengert et al (WO 97/06288 A1), as applied to claim 67 above, and further in view of Burk (US 5,788,777).

The combination of Kordina et al, Crawley et al and Wengert et al teach all of the limitation of claim 40, as discussed previously, except the substrate rotates in the heated flow channel reactor.

Burk teaches a modified susceptor for epitaxial growth reactors for growing silicon carbide epitaxial layers. The susceptor assembly has multiple substrate holders which are levitated and rotated by an inert gas flow (Abstract), this clearly suggests applicant's gas foil rotation. Burk also teaches the susceptor is made of graphite, SiC or SiC coated graphite (col 4, ln 10-12).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify combination of Kordina et al, Crawley et al and Wengert et al by rotating the substrate, as taught by Burk, because substrates which are levitated and rotated by an inert gas flow avoid cracking problems associated with high temperature growths ('777 col 3, ln 10-65) and because substrate rotation is used to average out non-uniformities in the heating and gas flow patterns.

Referring to claim 41, the combination of Kordina et al, Burk, Crawley et al and Wengert et al teaches substrate holders which are levitated and rotated by an inert gas flow which avoid cracking problems ('777 abstract and col 3, ln 10-25), this clearly suggests applicant's gas foil rotation.

Referring to claim 42, the combination of Kordina et al, Burk, Crawley et al and Wengert et al teaches silane and propane. ('320 col 5, ln 1-40).

Referring to claim 43, the combination of Kordina et al, Burk, Crawley et al and Wengert et al teaches the susceptor is designed to obtain a substantially uniform temperature ('320 col 2, ln 50-60). The combination of combination of Kordina et al, Burk, Crawley et al and Wengert et al is silent to the complete decomposition of the source gases produces growth rates of 10 mμ/h or more on account of a homogeneous temperature profile. The combination of Kordina et al, Burk, Crawley et al and Wengert et al teaches a uniform temperature is achieved, as applicant; therefore it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kordina et al, Burk, Crawley et al and Wengert et al by increasing the growth rate to 10 mμ/h or more to improve productivity.

Referring to claim 44, the combination of Kordina et al, Burk, Crawley et al and Wengert et al is silent to the reduction of Si clusters and seed formation is achieved by low temperature gradients perpendicular to the substrate. The combination of Kordina et al, Burk, Crawley et al and Wengert et al teaches a uniform temperature is obtained within the susceptor; therefore the reduction of Si cluster and seed formation is expected to occur because the combination of Kordina et al, Burk and Crawley et al teaches a similar small gradients, as applicant.

Referring to claim 45, the combination of Kordina et al, Burk, Crawley et al and Wengert et al is silent to the pressure of the process. However, pressure is well known in the art to be a result effective variable and the pressure claimed in within the known range of pressure conventionally used for CVD, as evidenced by Peters et al (US 6,097,039), note column 6, ln 45-65; therefore it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kordina et al, Burk, Crawley et al and Wengert et al by optimizing the pressure to obtain the claimed pressure by conducting routine experimentation.

Response to Arguments

11. Applicant's arguments with respect to claims 40-45 and 67 have been considered but are moot in view of the new ground(s) of rejection.

12. Applicant's arguments filed 11/14/2006 and 10/3/2006 have been fully considered but they are not persuasive.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Crawley et al is relied upon solely to teach cooling a reactant gas prior to entering the reactor to prevent premature reaction of the process gases and provide good mixing of the gases (col 1, ln 50-67). Kordina et al teaches the gases flow horizontally through the reactor (Fig 1).

Applicant's argument that Crawley teaches a vertical flow, which is perpendicular is noted but is not found persuasive. Crawley is not limited to a vertical reactor configuration, as suggested by applicant. The vertical reactor is merely a particular embodiment of Crawley. Crawley's method of cooling reactants prior to being introduced into a reactor is broadly taught for use with chemical vapor deposition precursors wherein conduits for supplying reactants to a reactor are cooled (col 2, ln 15-45). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to use Crawley method of cooling chemical vapor deposition reactants in the chemical vapor deposition process taught by Kordina et al where reactants pass horizontally over the substrate (' 320 Fig 1).

It is noted that applicant states that Wengert does not teach the newly added limitation requiring an opening of an inlet extends in a direction transverse to a plane of a front surface of the substrate for directing the gases to flow in a horizontal direction parallel to and past the front surface of the substrate. However, there are no particular arguments supporting this allegation. Wengert clearly teaches gases flow vertically then are turned to flow horizontally over a substrate (Fig 8), thus Wengert meets the claimed limitation.

It is also noted that applicant's arguments are directed to the Crawley reference which is only relied upon as a secondary reference to reject claims 40-45. Claims 46-66 do not rely on Crawley's cooling conduits, thus there are no arguments supporting claims 46-66 patentability.

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Nordell et al (US 5,759,263) teaches rotating a substrate about its axis during chemical vapor deposition to average out non-uniformities in the heating field and the gas flow pattern (col 2, ln 20-45).

Peters et al (US 6,097,039) teaches an epitaxial CVD method of SiC usually takes place at 1400-1800°C and 10,000-100000 Pa (100-1000 mbar), note column 6, lines 45-65.

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yogendra Gupta can be reached on 571-272-1316. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew J Song
Examiner
Art Unit 1722

MJS
January 21, 2007

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